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Neurosurgery in Uruguay: study of demographic situation and need for human resources

Neurocirugía en Uruguay: estudio de situación demográfica y necesidad de recursos humanos

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ABSTRACT

Introduction: the practice of neurosurgery is complex and is of paramount importance to have good trained professionals in each country. It is also important to have an adequate proportion between professionals and population. Material and methods: a survey was carried out in the Uruguayan Society of neurosurgery about: the number of neurosurgeons and residents, and some conditions of the work force (age, sex, number of surgeries per year, number of hospitals were they work). We also reviewed the number of surgeries in the country in 2023 and calculated the ratios of surgeries/surgeon and surgeries/residents. Results: Uruguay has 3,400.000 inhabitants, 42 neurosurgeons and 9 in training. There are also 5 foreign neurosurgeons trying to validate their degree. Of the 42 neurosurgeons, there are 27 males and 15 females, among residents, 8 are males and 1 woman. There were 3043 surgeries in all the country, with an average of 57.4 surgeries per surgeon at year. Just 28% of neurosurgeons performed more than 100 surgeries per year and 72% of neurosurgeons works in 5 or more hospitals. The ratio neurosurgeon/inhabitants is 1/82,.000. Discussion and conclusions: the correct planification of the work force of a given country must be based in the health system organization, the number of inhabitants and surgeries and the most frequent surgeries. Uruguay has an adequate but slightly high number of neurosurgeons per capita, considering national recommendations. However, their territorial distribution is appropriate. A solution for our country and other nations could be to have two levels of professionals - one group dedicated to treating prevalent and frequent pathologies in peripheral centers, and another group to receive and treat complex pathologies in referral centers.

Keywords: *neurosurgery; human resources; demographic study; reference centers.*

RESUMEN

Introducción: La práctica de la neurocirugía es compleja y es fundamental contar con profesionales bien capacitados en cada país. También es fundamental lograr una proporción adecuada entre profesionales y población. Material y métodos: Se realizó una encuesta en la Sociedad Uruguaya de Neurocirugía sobre: número de neurocirujanos y residentes, y algunas condiciones de los neurocirujanos (edad, sexo, número de cirugías al año, número de hospitales donde trabajan). También se revisó el número de cirugías en el país en 2023 y se calcularon las razones de cirugías por cirujano y cirugías por residente. Resultados: Uruguay tiene 3.400.000 habitantes, 42 neurocirujanos y 9 en formación. Además, hay 5 neurocirujanos extranjeros que buscan convalidar su título. De los 42 neurocirujanos, hay 27 hombres y 15 mujeres; entre los residentes, 8 son hombres y 1 mujer. Se realizaron 3.043 cirugías en todo el país, con un promedio de 57,4 cirugías por cirujano al año. Solo el 28% de los neurocirujanos realizó más de 100 cirugías al año y el 72% trabaja en 5 o más hospitales. La proporción de neurocirujanos por habitante es de 1/82.000. Discusión y conclusiones: La correcta planificación de la fuerza laboral de un país debe basarse en la organización del sistema de salud, la población, el número de cirugías y las cirugías más frecuentes. Uruguay cuenta con un número adecuado, aunque ligeramente elevado, de neurocirujanos per cápita, considerando las

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recomendaciones internacionales. Sin embargo, su distribución territorial es adecuada. Una solución para nuestro país y otras naciones podría ser contar con dos niveles de profesionales: un grupo dedicado al tratamiento de patologías prevalentes y frecuentes en centros periféricos, y otro grupo para la atención de patologías complejas en centros de referencia.

Palabras clave: *neurocirugía; recursos humanos; estudio demográfico; centros de referencia.*

1 INTRODUCTION

Neurosurgery is a highly complex specialty. This is not necessarily due to the technical complexity of all the procedures performed, but also to the possible complications and evolutions of the patients operated on[1-4].

Within neurosurgery, there are frequent procedures of relatively low technical complexity and others of high complexity and low frequency[5-7].

That is why neurosurgeons must have extensive basic training that is completed in Uruguay in 6 years of residency[6]. Subsequently, professionals must take advanced courses and it is desirable that they carry out internships outside the country.

Then they must maintain an adequate level of training that ensures their *expertise*. This occurs with a surgical volume that is estimated at a minimum of 3 surgeries per week[8,9].

Uruguay is a country with a population of less than 3,450,000 inhabitants according to 2024 data, and therefore it is important to have an adequate number of professionals who are fully dedicated to neurosurgery[10].

This is the only way to have specialists with a good level of training and trained to deal with neurosurgical cases[5,8].

The number of specialists must be adequate to the characteristics of the population (number of inhabitants, ages, prevalent pathology, material resources, etc.), in order to maintain a correct proportion between doctors/population/number of surgeries, that ensures a good surgical volume for surgeons and that the inhabitants receive the best possible care, as long as the professionals are trained and have satisfactory working conditions[5,7,8,11-14].

The authors analyze the current situation of neurosurgery in Uruguay, in order to obtain objective data on the human resources available in the country, to have a correct planning and maintenance of quality in human resources.

2 MATERIAL AND METHODS

A consultation was carried out within the members of the SUNC (Uruguayan Society of Neurosurgery) in October 2024, about the number of licensed and training neurosurgeons (residents and postgraduates), the number of centers where neurosurgery is performed and the volume of annual surgeries in each of them. It was taken for the analysis of the number of surgeries in 2023.

A survey was carried out among SUNC member neurosurgeons on: 1) basic demographic data (age and sex), 2) whether they are satisfied with their working conditions (conforming, non-conforming or partially compliant), 3) if they are not satisfied, the reasons, 4) in how many places do they work, 5) if they did internships outside the country, 6) if they would emigrate from the country and if so, the main reasons why they would do so, and finally, 7) they were asked to estimate the number of surgeries they perform per year.

Subsequently, recommendations from international societies were analyzed to estimate the number and characteristics of procedures that a neurosurgeon should perform per year.

Finally, with these inputs, a projection is made about the future of the specialty in the country, taking into account the specialists who are trained, retired, came from abroad to revalidate their degree or die practicing the profession.

3 RESULTS

In Uruguay there are 39 neurosurgeons with a qualifying degree, 2 professionals finished their residency but have not taken the final test.

Two doctors are taking postgraduate studies, not residency (one Uruguayan and one foreigner) and at the moment, there are 7 doctors taking their residency, resulting in 9 professionals in training.

There are 5 foreign doctors in the process of revalidating their specialist degree at the Ministry of Education and Culture (MEC). One of them has already received the result of the Technical Evaluation Commission that suggested to take two years of internship in public hospitals, having already complied with what was requested. The other 4 professionals have not yet had the instance of evaluation of the curricula and surgical records. Two of them have a transitory authorization from the MEC to work as specialists, despite the fact that their curricula has not been analyzed by an evaluation commission to see if there is training equivalence (two neurosurgeons graduated in Cuba).

Therefore, there are in Uruguay today: a) 39 licensed neurosurgeons, b) 3 in a position to take the final test, c) 4 in the process of revalidation, and d) 9 in the training stage (7 residents and 2 postgraduates).

The distribution by age and sex of neurosurgeons who are licensed or to be licensed (n:42) is shown in Table 1.

There are 35 centers in Uruguay where at least one procedure was performed by neurosurgeons in 2023. The distribution in the country is as follows: Montevideo is the city with the most centers where neurosurgery is performed (more than 20 centers), followed by Canelones[3], Maldonado, Tacuarembó, Rivera and Colonia (2 centers), Durazno, Salto, San José, Lavalleja and Paysandú (1 center in each department).

It should be clarified that all the places in the country where there is a record of at least one procedure in 2023 were counted, but obviously these places cannot be classified as "neurosurgery centers".

The total number of surgeries was 3,043.

In addition, 231 endovascular procedures were performed by neurosurgeons, but they are not included in the total number of surgeries. It was decided not to include them in the analysis since they are a specific field where only 3 neurosurgeons act and one of them fully and exclusively (without performing other neurosurgical procedures). Therefore, it was decided not to add these procedures together when calculating the number of surgeries per surgeon. On average, each endovascular neurosurgeon performed 77 procedures (range 63 to 105)

If we do not count the only neurosurgeon who is exclusively dedicated to endovascular therapy, we have at the time of writing this report, 53 professionals among graduates, in the process of graduating, in the process of revalidation or in training, to perform the 3,043 neurosurgical procedures.

This gives an average of 57.4 surgeries per year and per professional. This number is when measuring the total number of surgeries and professionals, however several clarifications must be made that will be analyzed in the "Discussion" section.

Regarding the survey carried out on neurosurgeons who are members of the SUNC, of the 42 graduates or about to graduate, 39 are members. A total of 32 responses were received (82% of

Table 1. Distribution of neurosurgeons in Uruguay, according to age and sex.

Age/Gender	30-40	40-50	50-60	60-70	More than 70	Total
Men	6	4	10	5	2	27
Women	7	4	3	-	1	15
Total	13	8	13	5	3	42

the partners). The 62.5% who responded are under 45 years of age, and 62.5% are male.

A total of 75% of neurosurgeons are partially satisfied with their work, and 25% are satisfied. Of those who are partially satisfied with their work, the main reasons for their dissatisfaction were multi-employment (73.9% of the responses) and work-life balance (65.2%).

Regarding multi-employment, it is noteworthy that 84.3% of Uruguayan neurosurgeons work in 4 or more hospitals (Table 2).

A total of 78% of the professionals carried out fellowships abroad as part of their training. Only 28% of professionals estimate that they perform more than 100 procedures per year (Table 3).

On the question of whether they would emigrate from the country, 12.5% answered yes. When reformulating the question and stating whether they would emigrate in case of current working conditions changed or worsened, 43.3% of neurosurgeons stated that they would be willing to emigrate.

Table 2. Responses to the question "In how many hospitals do you work?". From 32 responses, we can observe that 59% of neurosurgeons works in 5 or more hospitals.

Hospitals	Number of surgeons	%
1	0	0
2	1	3.1
3	4	12.5
4	4	12.5
5	4	12.5
More than 5	19	59.3

Table 3. Responses to the question "How many surgeries do you perform at year?". Over 32 responses, only 28% of neurosurgeons performed more than 100 surgeries per year.

Number of surgeries	Number of surgeons	%	Accumulative %
Less than 40	7	21.8	21.8
41-60	10	31.3	53.1
61-100	6	18.8	71.9
101-120	4	12.5	84.4
121-140	2	6.2	90.6
141-160	2	6.2	96.8
More than 160	1	3.1	99.9

4 DISCUSSION

Neurosurgery is a highly complex specialty that requires well-trained human resources that maintain a good level of training[1,5,12-14]. This, obviously, will benefit the population.

There are 39 neurosurgeons with a qualifying degree in Uruguay, but taking into account the professionals in a position to take the final test, we can estimate the more realistic number of neurosurgeons at 42. This does not take into account two foreign colleagues that the MEC authorized to work but that it is not possible to know if their training plan is equivalent to that of Uruguay, since they have not yet been evaluated by an advisory commission.

Number of surgeries in Uruguay

It is estimated that one neurosurgery is performed per 1,000 inhabitants per year in European countries[10]. This number is close to what we found in the national survey on the number of surgeries we carried out: 3,034 surgeries for a population of 3,450,000 inhabitants (0.88 surgeries per 1,000 inhabitants).

However, the number of surgeries found is lower than the 3,500 annual neurosurgeries estimated by Spagnuolo in 2016[15].

The national numbers are closer to one surgery per 1,000 inhabitants if we count the endovascular procedures performed by neurosurgeons, since we would have 0.95 surgeries per 1000 inhabitants.

Endovascular procedures are performed by 3 professionals who have specific training in these techniques and their non-inclusion in the total number of procedures responds to this and not to the fact that they are considered less complex. Many endovascular procedures are of high technical complexity, but the average neurosurgeon has no training in this topic during residency. This type of surgery can also be performed by neurologists or

neuroradiologists and in this report we only take into account those performed by neurosurgeons, so the number of endovascular procedures performed in Uruguay per year is higher than the one we present.

Therefore, the figure of one surgery (or procedure) per 1,000 inhabitants seems to be also valid for Uruguay.

Finally, we decided to analyze the year 2023 randomly. If we compare the surgeries performed at the Hospital de Clínicas de Montevideo in the period 2017-2019, in 2023 an average of 7.5% fewer surgeries were performed than in the aforementioned years[1]. We cannot estimate whether this number was replicated in the rest of the centers.

Number of neurosurgeons

Overall, it is estimated that there is a deficit of neurosurgeons in the world, but this is due to the very low number of professionals in developing countries[16]. The distribution of professionals is very uneven between different countries.

The number of neurosurgeons there should be is discussed in the literature, taking into account multiple factors: the ratio of admissions/retirements/deaths, economic remuneration, the number of procedures, the type of activity carried out by neurosurgeons, etc[11,14,17].

The optimal number proposed is 1 neurosurgeon per 100,000 inhabitants[10,18]. But as mentioned, this ratio is extremely variable in the world, ranging from 1 in 19 million people in the Republic of Congo to one in 16,000 inhabitants in Japan[11,16,19-21].

The latter is the highest relationship found and has several explanations. One of them is the type of work that neurosurgeons do in Japan: they actively participate in emergency departments, high demand for polyclinic hours (where they do not always see neurosurgical patients), active work in neurorehabilitation, very active participation in the areas of neuro-radiology, high dedication to endovascular diagnosis and treatment, action in the planning of radiosurgery and radiotherapy, and even 7% of neurosurgeons are solely engaged in basic research[11,21]. In Japan, patients with neurological symptoms often see the neurosurgeon directly, without going through a medical or neurological consultation. Kobayashi and Teramoto[11] state that only 30% of neurosurgeons are dedicated specifically to neurosurgical tasks. Therefore, the volume of surgery per surgeon in that country is very uneven and even this author recognizes that the average neurosurgeon in Japan operates fewer cases than European neurosurgeons[11]. In our opinion, these types of strategies are counterproductive since neurosurgeons are not neurologists who operate. Training in our country is neurosurgery, with basic knowledge of neurological diseases that are part of the differential diagnoses, but not of precise diagnosis, treatment and prognosis of neurological diseases.

There are different neurosurgeon/population ratios in the world: 1/16,000 in Japan, 1/39,800 in Greece, 1/61,000 in the USA, 1/64,000 in Germany, 1/89,000 in Spain, 1/150,000 in France, 1/232,000 in Canada, 1/290,000 in Great Britain, 1/2,500,000 in Gambia, 1/19,000,000 in the Congo, and in Ethiopia, in 1983 there was one neurosurgeon for every 32 million inhabitants[10,11,13,21-27].

We see then that the proportion is very unequal, with different health systems and different types of remuneration.

The world average is estimated at 1 neurosurgeon for every 230,000 people. In Uruguay, there is currently one neurosurgeon for every 82,142 inhabitants, which is close to - but slightly excessive - to that adequate by some international standards and clearly excessive by others[8,14].

Recommendations on the ideal ratio vary: some authors recommend 1 neurosurgeon per 100,000 inhabitants; the Canadian College of Physicians and Surgeons recommends 1 per 129,450 inhabitants[14,18]. Another recommendation is a team of 5-6 neurosurgeons for every 500,000 inhabitants and that these professionals work in the same reference center[14,18,22].

The latter allows for an adequate ratio between professionals and the population, but also allows for the organization of teams with areas of sub specialization, research, and resident training, which results in better patient care[5,8,12].

It should be borne in mind that the estimative of one neurosurgeon per 100,000 inhabitants arises from a 1977 study by Zuidema, and that the diagnostic and therapeutic reality has varied enormously in these almost 50 years[13,18]. However, recent studies continue to maintain this figure as a standard and taking into account the

number of surgeries that occur per 100,000 inhabitants, it is still valid and applicable[13,19].

It is important to note that the number of neurosurgeons is more influenced by the health system and its global organization than by the remuneration they receive, since for example, in Japan, which could be considered to be overcrowded and the "market" could lead to lower salaries, the average remuneration is 3 times higher than that they receive in Spain and is around 4 and 5 times lower than that of neurosurgeons in the USA[22].

For all these reasons, we believe that the entry of professionals into the residency system and the revalidations of foreign doctors' degrees should be regulated to maintain an adequate doctor/population relationship, in order to have qualified human resources that are satisfied with their labor insertion. Each country must study its own labor and care reality to have the best possible planning, taking into account the multidimensionality of the problem.

Number of surgeries and surgeons

A well-trained neurosurgeon is considered to perform surgeries regularly. They may be of low, high or intermediate complexity. The number of surgeries per surgeon is important for planning the training of human resources and their maintenance.

For example, a country's training and care system must ask itself several questions: how many surgeries should a resident perform per year? How many surgeries are carried out in the training centers? How many of them the residents do and how many the teachers do? What type of surgeries should a newly trained surgeon do? What number of surgeries is considered necessary to maintain a correct level of training after graduation?

The British Society of Neurosurgery proposes between 180 and 250 surgeries per year per surgeon to maintain a good level of training and that is why they plan for their population, 1 neurosurgeon for every 230,000 inhabitants. This gives an estimate of between 4 and 5 surgeries per week. In the European Union the average is 154 surgeries per year, in Spain 76 (although in some low-volume centers a neurosurgeon operates on 30 cases per year), Poland 70 and Greece 56 (approximately one per week), while in Japan it is estimated that there are about 30 per year per surgeon[10,25,28].

In Uruguay, taking into account that the distribution was equitable, we would have 72.4 surgeries per year per surgeon (3,043 for 42 surgeons).

This figure has several factors to consider.

First, in the 3,043 surgeries performed in the country, those performed by residents are not discriminated against. Therefore, the real figure is not 3,043/42.

Second, many neurosurgeons work mainly on an on-call basis, and therefore, they operate mainly in emergencies and not necessarily highly complex procedures. The "quality" of the procedures does not equal the number.

Third, the volume of surgeries is not evenly distributed and that is clear when we see how many places neurosurgeons work and how many surgeries they estimate they do per year. More than half of neurosurgeons estimate that they perform fewer than 60 surgeries per year (approximately 53%). This means that more than half are below average and 28% say they perform more than 100 surgeries per year, which would allow them to maintain an adequate level of training.

Many professionals state that they work in more than 4 places, but not necessarily for economic interest, but to maintain an acceptable surgical record. Rest and family time is sacrificed to achieve an acceptable number of surgeries, in order to maintain a good level of training.

If we break down the national figures, of the 3043 surgeries, 859 were performed in the training centers (Hospitals of Clinics, Maciel and Pereira Rossell, we also include the Hospital of Tacuarembó although it is not a teaching center). At the Hospital de Clínicas, 65% of the surgeries were performed by residents tutored by teachers and 35% were performed by teachers. If this ratio were maintained in all centers, the total volume of surgeries performed by residents in the public sector can be estimated at 558. This gives an average of 62 surgeries per year per professional in training. It is clear that this is an estimative based on the distribution of surgeries in a university center and is not necessarily maintained in the rest of them.

This would lead us to make a correction in the average number of surgeries performed per qualified surgeon: of the 3,043 surgeries analyzed to calculate the average, the 558 (in theory) performed by residents must be subtracted.

Therefore, there are 2485 surgeries performed by 42 surgeons, which gives an average of 59.2 surgeries per year.

The number of surgeries per year per resident would be 62, but this figure could drop to 47 if all foreign neurosurgeons applying for revalidation were asked to be interned by public hospitals and to perform surgeries to complete an adequate surgical record. These estimates are made taking into account that the distribution of cases was equitable among all professionals in training.

In the 2002 neurosurgery residency curriculum, prepared by Professor Eduardo Wilson, it is stated that there must be a minimum volume of 100 surgeries per resident per hospital and that the resident must participate in a minimum of 200 surgeries as a surgeon and 300 as an assistant at the end of the residency[6]. The standard set forth in this curriculum is met, but the volume of surgeries set by international standards is not met, so it is pertinent to update the curriculum in terms of its implementation, teaching strategies, number and quality of surgeries that a neurosurgeon in training must perform. In fact, a commission of three university professors is developing a curriculum adapted to the new teaching and care reality.

For all that has been analyzed, the number of neurological surgeons that Uruguay has based on the country's population and using the international proportion (1/100,000 inhabitants), is somewhat excessive and if we base it on the number of minimum surgeries required (3 per week: 130-150 cases per year), it is also excessive. Our country should have 34 neurosurgeons, organized in reference centers for complex pathology and others decentralized only to solve emergency surgeries, which conceptually is defined by "the triple H" (Hydrocephalus, Spontaneous, Traumatic or Hypertensive Hematomas, Herniated Discs, etc.). However, in the absence of a national organization that regulates and orders medical practice and the operation of the centers, this does not happen. There is a profusion of places where neurosurgery is done, but there are no audits that see its quality and results.

Age and sex characteristics

In the world, neurosurgery is an "aged" specialty[10,28,29]. This is partly due to the time it takes to train and begin to practice fully. In Uruguay, half of the neurosurgeons are over 50 years old and 3 (7%) are over 70 years old and continue to practice.

In our country there is no age limit for on-call duty, in Europe the maximum age is 55 years, although it can then be exercised but not by doing emergency shifts[10,28].

In terms of sex, Uruguay has a high number of female neurosurgeons compared to the rest of Latin America[30]. Most women neurosurgeons are under 50 years of age, an age group in which they represent 53% of professionals.

At the time of writing this report, only one woman is doing the residency, which represents 14% of the residents. This fact is circumstantial since in previous years women represented more than half of the residents.

Education and belonging

It is noteworthy that almost 80% of Uruguayan professionals have carried out internships abroad to improve their training. This translates into a high commitment to the profession and its practice. Internships and fellowships in foreign centers are generally financially paid for by professionals and rarely have institutional funding or economic support (Sectorial Research Commission, University of the Republic).

On the other hand, it is also noteworthy that about 90% of Uruguayan professionals want to develop their work in the country and do not wish to emigrate.

However, this figure falls to about 55% if a worsening of working conditions is considered.

Training a neurosurgeon is a long and complex process that does not end with the delivery of the degree but continues later with courses, internships, etc.

Therefore, it would be desirable for no country to lose trained human resources due to worsening working conditions (low

remuneration, unsatisfactory conditions of exercise, lack of access to technology, etc.).

This problem is not Uruguay's patrimony: Canada estimates that the training of a neurosurgeon costs close to one and a half million dollars and despite having good working conditions, young neurosurgeons migrated to the United States for better remuneration conditions[10].

Future planning

When planning the number and type of human resources to be trained, multiple dimensions of this problem must be taken into account[29].

a) Number of inhabitants.

b) Demographic characteristics (prevalent ages and pathologies).

c) Geographical distribution and characteristics of the country.

d) Training capacity (centers and surgical volume).

e) Material resources for practice (intensive care, microscope, tomographs and MRIs, etc.).

f) Other human resources (neuroanesthesiologists, qualified OR nurses, nurses with specific training, qualified assistants).

g) Profile of the neurosurgeon (who operates, but who think correctly from the clinical point of view, research, empathy, resilience, leadership, social commitment, etc.).

We acknowledge this is a multidimensional problem discussed in the world[19,28]. In an attempt to simplify these complex variables, we will take into account some inputs to present the current and future situation.

In different countries there have been antagonistic situations with human resources in health, and even in the same country over the years this has also happened: the shortage or excess of human resources. For example, in Canada there was a shortage of neurosurgeons because they migrated to the United States for better pay. However, after the United States placed obstacles in the way of revalidating degrees for foreigners, young Canadian neurosurgeons reported difficulties in fully dedicating themselves to the profession and obtaining satisfactory working and economic conditions in their own country[14]. In Spain, it is considered that there is an inadequate number of professionals (lower than required) and in Argentina that there is an overpopulation[13,31-33].

Both situations (excess or lack) have a negative impact on the population and professionals. The development of the specialty with a shortage of human resources can leave the population in a situation of lack of access in time and form to professionals, with a negative impact. On the other hand, an unjustified multiplication of neurosurgeons can direct their use to tasks not specific to the specialty and lead to a gradual disqualification of most of these neurosurgeons for the tasks they must perform. For example, we see that in our country unjustified consultations are made for cases that should be solved by other specialties or even general practitioners (low back pain, for example). Having few professionals will cause these consultations to be delayed but, on the other hand, they are not at all gratifying or justified for a professional who takes 14 years to enter the labor market. Having a greater abundance of professionals will lead to a multiplication of consultations that do not require the participation of a neurosurgeon per se: mild brain trauma with normal CT, low back pain, sciatic pain without studies or treatment for adequate time, headache without imaging studies, etc.

As surgical specialists we believe that we should spend most of our time dedicated to this part of our specialty, understanding very clearly that consultations in emergency departments, hospitalization and outpatient clinics must be done in a timely manner, but most of the professionals consulted see an increase in consultations that they consider unnecessary.

The number and geographical distribution of neurosurgeons has an impact on the health of the population and is a more complex issue than just looking at the proportion of neurosurgeons per inhabitant.

It is always suggested that the surgical volume of each specialist is key to maintaining a good level of training. However, in some geographical or demographic conditions it may be acceptable to have less trained professionals who can solve emergencies, as can happen in Australia. In this country patients have to travel long distances to find reference centers, so it may be acceptable to have a neurosurgeon who with less training in complex pathologies,

but who can quickly and efficiently solve traumatic, spine and basic vascular pathology.

A study conducted in the United States showed that regions with a higher density of neurologists and neurosurgeons have lower mortality in the treatment of stroke and head trauma[31,32]. In a study carried out in Uruguay, it was observed that a reference center in the interior of the country (Hospital de Tacuarembó), received more neurosurgical patients from the Departments that had neurologists and a tomograph[3]. We could accept that the greater presence of neurosurgical or neurological specialists pushes the system to be more aggressive in the diagnosis and treatment of neurosurgical pathology.

For all these reasons, in some countries (including Uruguay) it might be acceptable to have a title of "basic neurosurgeon" or "emergency surgeon" (first-degree neurosurgeon in countries such as Cuba) that allows for professionals trained to quickly resolve the basic pathology that requires immediate attention (traumatic or hypertensive brain hematomas, decompensated hydrocephalus, for example) while "certified neurosurgeons" could resolve the most complex pathology (tumors, complex vascular pathology, functional neurosurgery, etc.).

This issue should be discussed in each national scientific society and in that case, it may be acceptable to increase the number of neurosurgeons to have more decentralized hospitals that can solve the less complex pathology, sending the most complex cases to tertiary centers. This should be done under very clear care rules and emergency neurosurgeons could evolve if they wish, through courses, training stays and tests.

But if the planning in the generation of human resources is going to be changed, the system of care and work should first be changed and propose, for example, that the positions of emergency neurosurgeon should be developed in a decentralized way, with a commitment of the professional who assumes it, to practice where it is required once he/she obtains the degree. Or in the same way, foreign qualifications can be revalidated (which obviously comply with the regulations of each country), provided that they practice in places where the emergency pathology needs to be resolved. The latter strategy has been used in other countries to meet the demand for some specialties in "unattractive" places[33]. It is a global problem that physicians with specialties intend to practice in an environment that generates an adequate critical mass of patients and therefore, they are concentrated in large cities[29,33,34].

A 2013 study carried out in the US assumed that there could be a shortage of neurosurgeons, however the real figures showed that there was one for every 66,000 inhabitants. This proposal of lack of professionals arose because there was a high demand in the labor market: 305 publications looking for neurosurgeons[35]. These requests were to cover urgent and trauma emergencies in small cities. The conclusion was that there were not a few neurosurgeons but that they were poorly distributed or that the type of practices for which there were offers were not comforting or attractive to them.

It is not easy to plan care strategies, but for example, the Argentinian Association of Neurosurgery proposes "to promote the reform of the distribution system of residents in the country. Acquire a policy of regionalization of the health system". He also proposes "Creating sub-specialization in neurotrauma and generating sub-units in *ad hoc hospitals*. A large number of emergency consultations and neurosurgeries are due to trauma, so the fact that residents without a job placement project can be trained to develop units that solve this pathology is a solution for the young neurosurgeon and for the health system"[13].

In summary: organizing trauma centers with professionals dedicated to solving this pathology can solve a care and labor problem in many parts of the world. It may be useful to have "intermediate" qualifications, with 3-4 years of training that allow emergency resolution by neurosurgeons with basic training.

Number of inhabitants, distribution and number of surgeries

Uruguay is a country with a very stable population. In 1990 there were 3,122,000 inhabitants, in 2000 3,349,000, in 2010 3,397,000 and in 2020 3,429,000[35,36]. This shows an increase in the population of 307,000 inhabitants in 30 years, simplifying it would result in approximately a 9% increase in 30 years. Again, simplifying the situation, this should be the rate of increase in the neurosurgical population to maintain an adequate surgeon/inhabitant/surgery ratio for our country.

However, although the absolute number of inhabitants increased, the rate of population increase is negative according to the National Institute of Statistics and this increase has been basically due to

immigration and not to the growth rate of the "autochthonous" population[35,36].

The age of the population is important since the cause of death in older populations is cardiovascular disease and cancer. The country's population trend is downward between 14 and 64 years of age and an increase in those over 65 years of age. This could mean that more specialists trained in cerebrovascular pathology, degenerative spine and oncology will be needed. Projections of the real needs for the number and quality of neurosurgeons cannot be made with these data, but it is important to take them into account.

Uruguay is a country with a small surface area and few geographical features that threaten the rapid transfer by land of patients who require specialized care. Uruguay has a territory of approximately 187,000km^2 divided into 19 departments, only 8 have more than 100,000 inhabitants and all of them have neurosurgery centers. Three departments have neurosurgeons based there (Paysandú, Rivera and Salto). Sixteen departments (including the above) have more than 50,000 inhabitants and two do not reach 50,000 (Flores and Treinta y Tres). Therefore, Uruguay must regionalize neurosurgery care (which is done partially) and it does not seem to make sense to open more centers in the interior of the country or, failing that, these should solve the basic emergency pathology and refer the most complex pathology to tertiary centers.

Taking into account all these data, it does not seem that there will be an increase in the number of neurosurgeries performed in our country unless the number of indications for them increases. This would only occur if neurosurgeons "dispute" procedures that can be performed by more than one specialty: peripheral nerve surgeries, carotid endarterectomies, spine surgery, pain management procedures, etc[29]. Other options are the appearance of new technologies that make pathologies that today have no indication for invasive therapies.

For all these reasons, it would be expected that the number of procedures and the increase in the population will not be a determining factor in the projection towards a future increase in the needs of human resources in neurosurgery, at least in Uruguay and in the short term.

Admission and Expenditure Rate

In Uruguay, in general, 3 residents enter in the training centers every 2 years (one year one resident, 2 residents the following year). In a 6-year cycle, 9 neurosurgeons enter to be trained. Of these 9, 8 enter as residents and one as a postgraduate (quota for foreigners required by the Graduate School of the University of the Republic). This income rule (one year one income and the next two incomes) has been modified on some occasions, with only one resident entering per year for two periods.

The rate of retirements from the profession is low and most neurosurgeons work beyond the age of 65, which is repeated in several countries around the world[22,27-29].

In the last 5 years, 5 neurosurgeons retired from the practice of the profession and in that same period 5 residents and a postgraduate degree entered the training plan, showing a 1/1.2 ratio between discharges and income. If we add the foreign doctors who made the entry of their degree for revalidation (5 doctors) this index becomes 1/2. This is easy to interpret: for each neurosurgeon who retired in the last 5 years - when taking into account the current revalidations - 2 can enter. If this trend continues, a greater overpopulation of neurosurgeons than the current one would be expected, which has already been shown to have a negative impact on the group[29].

How does it have a negative impact? In Uruguay, training a neurosurgeon took about 13-14 years between undergraduate and postgraduate studies. Currently, applicants enter through the Single Residence Test (PUR), which is similar to the MIR in Spain. This modality was implemented two years ago, previously the specialty was entered by a specific test. This means that, at least in theory, those who enter the residency now do not have neurosurgery as their primary vocation. The choice of specialty with MIR type tests is associated with up to 9% dropouts, while so far there have been no dropouts in our specialty in the country[28]. If there is overcrowding and there is not a correct job placement, it is possible that young neurosurgeons leave the specialty or emigrate to other countries, as happened in Canada[14]. Training a valuable and high-quality human resource and then losing it should be seen as a failure of the system and, therefore, we must make every effort to provide a good quality of work, life and free time to professionals so that they choose to stay and practice in their country[29]. The majority of national neurosurgeons are not completely satisfied with their work and the reasons given for this dissatisfaction are multiple jobs (74%) and work-life balance

(63%). Only 40% are partially satisfied with the remuneration they receive or with their professional development. The overpopulation of professionals will possibly lead to greater multi-employment, a drop in job quality and remuneration, which will further affect the quality of work.

Likewise, the same level of training should be required for revalidations for foreigners and analyzing the turnover rate (graduates/income) of professionals, we believe it is necessary to regulate the number of revalidations that are granted in our country, if this trend continues.

One proposal may be to grant a fixed number of revalidations per year, analyzing the rate of entry of residents and departures from the labor market due to retirement, disability or deaths. Another important point is to look at the training plans in the country of origin, which can lead to the request for some tasks to bring the plan into line with the requirements in the country where you want to practice.

In 1983, Uruguay had one neurosurgeon for every 88,182 inhabitants, so we can say that in the last 40 years, training policies have not been at all restrictive and have been adequate to maintain a more or less stable relationship between the number of professionals and the population[23].

The indiscriminate entry of degrees for revalidation or professionals into the training plan can negatively unbalance a balance that has been correct and that seems to indicate that there have been no "mercantilist" restrictions on the number of neurosurgeons trained in our country. Moreover, the ratio between professionals and the population is higher today than in 1983: 1/82,000 vs 1/88,000.

For comparative purposes, Denmark in 1997 had a population of 5.2 million inhabitants and the admission of residents to the training plan was 1-2 per year, with a retirement age of approximately 70 years[37].

In Uruguay, professionals usually retire at an age close to 70 years and we have a similar number of admissions to Denmark, but with a population that is 65%[37]. In that country, there were 5 neurosurgery centers at the time of the report. In Uruguay there are more than 30 sites where neurosurgical procedures are performed. It is clear that the interest of our report is to analyze the number of working professionals, given that we run the risk of having an overpopulation of professionals if this trend of revalidations (having the same number of admissions of residents and postgraduates) is maintained over time. In our opinion, the opening of centers that perform neurosurgery with a very low number of surgeries must be rationalized, because this threatens the training of personnel (nurses, OR nurses, floor doctors, postoperative care), increases multi-employment, the time that professionals invest in traveling, etc. All of this negatively impacts the level of care given to patients.

Neurosurgery is a specialty that requires quality postoperative care and it is necessary that all the personnel surrounding the surgical act have an excellent level of understanding of what they do, how to manage the pre, intra and postoperative period. With centers having a very low volume and high staff turnover, it is extremely difficult to achieve the goal of having trained staff.

Finally, in the last 5 years, no neurosurgeon died while they were of active working age, so the death rate in our country has no impact on human resources planning.

Geographical distribution

Uruguay has a "macrocephalic" distribution of neurosurgeons, but not of neurosurgical centers.

There are only 3 neurosurgeons living in the interior of the country (7%): Salto, Rivera and Paysandú. However, neurosurgery is performed in a regulated way in 8 departments of the interior of the country. In the world, this trend occurs due to the organization of neurosurgical centers, that is, neurosurgeons and neurosurgical centers are concentrated in the largest cities[10,22,29]. This is logical because of the critical mass of necessary surgeries but also because of the rationality of investing in physical resources (instruments, microscope, ICU, MRI, tomography, arteriography) and human resources (trained personnel).

Not only for this, but the largest centers can have the capacity to train neurosurgeons. Today, the main training center is the Hospital de Clínicas, where the Teaching Service is located. The Maciel and Pereira Rossell hospitals are associated to an universitary unit. The Tacuarembó hospital is not an universitary neurosurgical service unit but offers work to residents from the third approved year, where they begin to do internal shifts. In

practice, this center has an unqualified neurosurgical specialist who can solve the emergency pathology.

It does not seem reasonable to continue opening training centers due to national needs. In Argentina, the profusion of training centers has led to the availability of "cheap labor" but at extremely disparate levels in the quality of neurosurgeons[13].

The authors consider that no more facilities should be opened where coordination neurosurgery is performed and it is debatable whether to open centers where emergency surgeries are operated in our country. This would have to be carefully planned to obtain the benefits of decentralization but without impacting the quality of care and work.

More centers will have a negative impact on neurosurgical work since more labor is needed to cover distant locations, which generate work but of very poor quality (in terms of volume of surgeries and the decrease in the free time of professionals who invest many hours in traveling). They can mean economic savings for institutions, but the negative impact on the system is greater than the real benefit since the nursing staff, doctors who participate in postoperative care and instrumentalists will have very little experience, as is currently the case in some centers. We agree with Poza's statement[28]: "he creation of new (neurosurgery) services is not always based on demographic reasons but rather on demagogic issues". Regulatory authorities should intervene at this point, setting the minimum care guidelines necessary to open a trauma and coordination "neurosurgery center".

How many residents to train per year?

This is a very important point, because it can be frustrating to train a very valuable human resource who invests 13-14 years of his life so that they do not have full labor insertion (due to an excess of specialists) or that they are subjected to excessive work (due to a lack of specialists).

It must be taken into account that, as the training process takes 6 years of specialization, if there is a significant lack of human resources, it will take years to replace the deficit.

In Europe, there are 5- and 6-year training plans that are accessed by competitive examination or interview and curriculum vitae[28].

It is important to bear in mind that the number of residents is determined based on the demographic needs of the population, the number of active surgeons, retirements, adaptations to time restrictions (how many hours per day and how many days a neurosurgeon must work), dedication of doctors to teaching with less care load, etc[28].

In the United Kingdom, which has a population of almost 67 million, in 2001 between 10 and 12 residents entered per year[28]. In France, 10 per year and it is estimated that in 1995 there were 110 residents in training, of which 65 were foreigners, and at that time there were 300 neurosurgeons for 60 million inhabitants. In Holland, it was proposed that every neurosurgeon should have a job when they graduated, so they limited income and planned positions year by year. The Dutch were going to train abroad and then return and the Dutch Society of Neurosurgery, concerned about the level of training of those who returned, decided to open more vacancies. In the USA, the fixed income of 135 candidates is selected by curriculum and recommendation of the deans and tutors of internships[28].

Uruguay had a specific test of the specialty until 2022, with one admission per year and in alternate years, two admissions. With this guideline, the maximum number of residents is 9, which ensures adequate training, although as we can see, with a relatively low number of surgeries and a relatively stable neurosurgeon/population ratio, but this is on decline.

When the modality of the test changed and postgraduate courses were opened for foreigners, it was decided to reduce the number of residents to 8 and call a postgraduate degree every 6 years in order to maintain the best possible surgical volume for doctors in training.

It is clear that the policy of the Responsible Teaching Unit (Hospital de Clínicas, University of the Republic) has not been restrictive in the least, but clearly adapted to national needs. But under the current conditions it would seem logical to limit the number of revalidations that are granted or to reduce the number of residents to be trained. This seems to be the only strategy to avoid having an overpopulation of neurosurgeons who will have increasingly basic training and worse working conditions.

5 CONCLUSIONS

Uruguay is in a complex moment with respect to the training of human resources in neurosurgery.

The rate of neurosurgeons per inhabitant is above international standards (one in 82,000 inhabitants against the recommendation of 1 in 100,000), the number of surgeries that each of them has is lower than that proposed by international standards (although clearly many professionals reach that standard or even exceed it because the distribution is not homogeneous).

The volume of surgeries per resident is low according to international standards.

Planning the number of professionals is necessary in health systems to ensure the availability of human resources in health, who are adequately trained to provide care to the population when and where they are needed. This planning is part of the strategies and recommendations of international organizations, with the purpose of seeking the most appropriate balance of different types of professionals and their distribution. Surplus or shortage of labor can decrease productivity and efficiency, deplete scarce resources, and waste the skills of professionals. Uruguay is at a time when it must decide which path to be taken: the massification of poorly trained neurosurgeons or the orientation to quality human resources concentrated in reference centers.

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